situations in which such sharing arrangements are infeasible, the use of TDMA or CDMA technology apparently would not impose a cost penalty on rural users.[28] Indeed, rural users could be expected to benefit from the increased competition that would arise if the Commission and other federal agencies do not lock in the use of FDMA through regulatory or procurement policies. Third, to the extent that there is a tradeoff in terms of spectral efficiency in different user environments, it would be that TDMA and CDMA have the best fit in large urban areas, while FDMA has an advantage in rural areas. Spectrum congestion—both for public safety wireless and more generally—is a much more serious concern in urban areas than rural.[29] In other words, the opportunity cost of spectrum is much higher in urban areas, and thus it is more important to economize the use of spectrum in urban areas than in rural.

The first three points suggest that TDMA and/or CDMA are superior to FDMA in terms of their overall contributions to the efficient use of the spectrum. However, there is a final important point in the debate over spectral efficiency. To the extent that one technology is better suited for some applications and worse suited for others, public safety radio is an area in which an industrywide standard would reduce the benefits of variety. Rather than forcing all public safety radio users to adopt a single technology, it may be preferable to let each user pick the technology that best meets its needs.[30]

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promote the use of shared systems in its *Second Report and Order,* PR Docket 92-235, released March 12, 1997, ¶23.

28 See, for example, G. Calhoun, *Digital Cellular Radio,* Norwood, MA: Artech House, Inc., 1988 at 410-415.

29 See, for example, "Final Report of the Public Safety Wireless Advisory Committee," September 11, 1996 at 2 and 666.

30 This point is made in "Comments of The California Department of General Services Telecommunications Division" in WT Docket 96-86 at 14-15.

B. Limited Interoperability

At present, public safety radio systems operate on several non-contiguous blocks of spectrum. This pattern of spectrum allocation poses a serious challenge for attempts to achieve interoperability across public safety radio systems: a challenge that the APCO Project 25 specification does not meet.[31] By itself, this point raises the issue of whether public safety users should bear the costs of implementing this specification. Moreover, there may be alternative means of achieving interoperability that engender lower social costs. In particular, serious consideration should be given to: (1) sharing common systems among multiple users in an area, as some users already are doing;[32] and (2) creating gateways (or what economists generally refer to as *adapters*) through which different systems can communicate with one another. Of course, the use of adapters and systems sharing each gives rise to its own costs. What is needed is full public interest assessment of the costs and benefits of the alternatives.

C. Limited Ability of Public Safety Users to Utilize New and Advanced High-Bandwidth Services

Because FDMA technology relies on narrow channels, it is ill-suited for many advanced services (*e.g.*, data and video imagery transmission) in comparison with TDMA or CDMA.[33] It is notable that, as they move to digital technologies, private sector telecommunications providers are generally moving toward all-purpose systems because of the economies of scope and advantages of flexibility that reduce the cost of meeting the needs of a changing service mix.

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31 *NPRM* ¶22.

32 As discussed in the *NPRM* ¶32, this approach is being taken by public safety agencies in California, Colorado, and other states.

33 See, for example, G. Calhoun, *op. cit.* at 417-418.

This is true of television (with the move to more flexible digital systems capable of transmitting multiple video streams, as well as data) and wireline telephony (where providers are moving toward integrated voice and data networks). More important, it is true of wireless telecommunications. For example, digital cellular and PCS providers in the United States are adopting TDMA and CDMA, not FDMA. And a broad coalition of manufactures, users, and regulators is developing the TETRA standard—which incorporates TDMA, not FDMA—to meet European public safety agencies' wireless communications needs.[34]

D. Competition in the Supply of Public Safety Wireless Infrastructure and Handsets would be Diminished

According to the report prepared by Hatfield Associates, Inc.,[35] public safety radio users have idiosyncratic needs that limit the extent to which they can substitute general purpose radio systems for systems designed explicitly to meet public safety requirements. Based on the Hatfield analysis, it is reasonable to conclude that the relevant market for a competitive analysis comprises conventional plus trunked public safety radio. Only a relatively small number of firms are active suppliers of public safety radio equipment. Figures provided by Ericsson indicate that Motorola is by far the largest provider, with 71 percent of the market, and Ericsson is a distant second with 19 percent. In light of the oligopolistic conditions and Motorola's high market share, it is important that any standard setting promote, rather than discourage, competition.

There are, however, several mechanisms through which adoption of the APCO Project 25 specification as a standard could adversely affect competition:

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34 http://www.tetramou.com, March 21, 1997.

35 Hatfield Associates, Inc., "Competitive Considerations Associated with APCO Project 25", January 15, 1996 at 2-13.

- Although the APCO Project 25 specification might be thought of as an attempt to increase compatibility, in some ways it is a step in the opposite direction. The Project 25 specification does not currently contain the equivalent of an A interface, and the lack of an A interface may make it more difficult for firms to compete on the basis of specific subsystems.[36] This would have the effect of favoring incumbents that are systems producers, and it denies consumers the opportunity to best meet their needs by mixing and matching components by different manufacturers. Second, this failure to specify an open interface makes it more difficult for firms to enter on a less-than-fully-integrated basis. To the extent that firms are forced to enter into the production of more components at once, the costs and risks of entry are increased, which will tend to reduce the likelihood of entry. Moreover, there may be sufficient economies of scale in the production of some components that it is inefficient to have a large number of producers of that component. Absent the ability to unbundle systems, however, each producer may inefficiently be forced to produce the full range of components. Considerations such as these are what led the Congress to require in the Telecommunications Act of 1996 that local exchange carriers unbundle their networks and have several points of interconnection with other carriers.

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[36] The closed interface between the switch and the controller infrastructure corresponds to the key interface referred to as the A interface in cellular systems. When this interface is proprietary, it is difficult for anyone but the original systems vendor to supply upgrades or expansions. See C.L. Jackson, "A Need to be Heard: Will Project 25 Meet Public Safety Communications Needs in 1995 and Beyond?" Strategic Policy Research, July 1995 at 13-15.

- The APCO Project 25 specification may favor Motorola in terms of building on corporate know how that will allow it to be a relatively low-cost producer. For example, the common air interface working channel protocol appears to be the same as that used in Motorola's existing product line. And although similar types of modulation are publicly available, the Project 25 specification incorporates Motorola's proprietary modulation as used in its ASTRO™ products.[37] While any standard may tend to favor one producer or another, it is important to examine the potentially adverse effects on competition from favoring the dominant incumbent before mandating a standard.
- Motorola controls key intellectual property rights that are essential to implementation of the Project 25 specification.[38] There are at least five concerns that are raised by the terms on which Motorola is willing to license its intellectual property to Ericsson to allow the latter to produce APCO Project 25 compliant systems.[39]

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37 See Motorola ASTRO Digital SPECTRA™ Portable Radios and Digital SABER™ Portable Radios product information sheets, R3-1-160 and R3-4-161, 1992, and United States Patent, Wilson et al., US 5,377, 229, *Multi-Modulation Scheme Compatible Radio,* December 27, 1994, assigned to Motorola, Inc.

38 This stands in stark contrast to the European public safety digital trunked radio standard. "[M]anufacturers of TETRA radios do not have to license technology from anyone" [emphasis in original]. "TETRA and APCO 25 Prepare to go Protocol to Protocol Worldwide," *Land Mobile News* **50** (September 6, 1996) at 1.

39 These terms are summarized in Letter from Wayne Leland, Motorola Inc. to Steven Montealegre, Ericsson GE, May 4, 1993. These terms are reiterated in Letter from Gary N. Houdek, Motorola Inc. to Steve Montealegre, Ericsson GE Mobile Communications, October 28, 1993. The terms stated in these letters apparently continue to be the terms on which Motorola is willing to license this intellectual property to Ericsson because the author has been informed that no further substantive discussions have ensued since late 1993. Similar product and geographic restrictions are contained in the License Agreement of August 2, 1994 between Motorola, Inc. and Transcrypt International attached to Transcrypt's Form S-1 filing with the Securities and Exchange Commission, October 1996.

1. The Definition of What Constitutes an "Essential" Patent is Subject to Dispute.

Motorola has expressed a willingness to accept certain licensing terms only for those patents that are essential to producing APCO Project 25 compliant systems. Ericsson disagrees with Motorola's assessment of what is and is not essential.[40] It is crucial that the Commission or some other neutral party get to the bottom of this dispute before locking-in a standard that Motorola might later be able to control through the exercise of intellectual property rights for patents that it deems non-essential but rivals find essential. As noted by Dr. Shapiro,

> Intellectual property rights are attenuated when a firm controlling intellectual property--patents copyrights, or trade secrets--relevant to a standard has committed itself to an "open" standard in order to obtain industry support for the standard in the first place. In that situation, subsequent efforts to gain control of that standard by asserting these same intellectual property rights can implicate competition and raise antitrust concerns.[41]

The remaining concerns center on the terms under which Motorola is willing to license its intellectual property. In discussing these licensing practices, it is important to keep the following points in mind. As an intellectual property rights owner, Motorola generally has broad rights to choose both the firms to whom it licenses its intellectual

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40 Motorola has identified several patents that it considers essential under the terms of the IPR MOU. Ericsson claims that Motorola holds additional patents for certain features desired by customers and not identified as "essential" by Motorola. (See, for example, Letter from Steven E. Montealegre, Ericsson GE to Wayne Leland, Motorola Inc., November 3, 1993 at 3 and attachment to Letter from Wayne Leland, Motorola Inc. to Steven E. Montealegre, Ericsson GE, December 3, 1993.) Ericsson has informed the author that the disagreement between Motorola and Ericsson over which patents are essential continues.

41 C. Shapiro, *op. cit.* at 23.

property and the terms on which it does so. However, as just discussed, these rights are significantly attenuated when Motorola agrees to have its intellectual property incorporated into what is supposed to be an open standard. Alternatively, if Motorola is unwilling to license its technology on terms that promote competition, it is free to do so, but then it's technology should not be the basis of a standard.

2. *Product Restrictions Regarding Essential Modulation Technology.* Motorola has offered to license the designated patents royalty-free "solely for use in allowing manufacture, sale and use of equipment that meets the APCO 25 standard and application."[42] Depending on the terms demanded elsewhere, this limitation can have the effect of preventing the realization of economies of scope by a producer seeking to share certain costs across products when some of the other products do not meet the APCO Project 25 specification. Motorola would, of course, be free to use the technology in other applications (*e.g.,* the supply of private radio systems to railroads or electric utilities). Thus, the effect can be to create a competitive advantage for Motorola by inflating the costs incurred by rival suppliers. It is highly unlikely that public safety users will benefit from a practice that raises the costs of Motorola's competitors.

3. *Geographic Restrictions Regarding Essential Modulation and Frame Technology.* Motorola has offered royalty-free licensing for products produced "for sale to users

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[42] Letter from Wayne Leland, Motorola Inc. to Steven Montealegre, Ericsson GE, May 4, 1993 at 1.

of Standard compliant systems in North America."[43] The economic effects can be expected to be similar to those of product restrictions. Depending on the terms demanded elsewhere, this can have the effect of preventing the realization of economies of scope by a producer seeking to manufacturer compliant systems.[44] The likely consequences would be to raise rival's costs, weaken competition, and harm North American consumers of public safety wireless equipment.

4. *Discriminatory Royalty Rates for the Licensing of Frame Technology.* Motorola has proposed charging a higher rate to those licensees who "do not manufacture the subject product in North America" than to those who do.[45] This pricing structure raises the costs of pursuing a global production strategy of the sort that many firms in a large variety of industries find to be profitable. It is difficult to see how the license fee difference could be related to any difference in underlying costs to Motorola, and this appears to be a case of price discrimination. Indeed, it is difficult to see how this pattern of pricing is tied to consumer demands (the usual basis for price discrimination). This fact suggests, although is not conclusive, that Motorola is motivated by strategic considerations, such as disadvantaging rivals with offshore

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43 Letter from Wayne Leland, Motorola Inc. to Steven Montealegre, Ericsson GE, May 4, 1993 at 1 and 2. In the letter (at 1 and 2), Motorola states its willingness to license on favorable terms if the authorities in another country meet certain conditions that Motorola has set for them. It is difficult to see the public interest in allowing Motorola to determine U.S. trade and communications policy.

44 A letter from Craig M. Jorgensen, Project Director, Project 25 Steering Committee, to Edward J. Kelly, Ericsson GE, September 30, 1994 suggests that the Project 25 Steering Committee did not recognize this as a significant issue when choosing the specification.

45 Letter from Wayne Leland, Motorola Inc. to Steven Montealegre, Ericsson GE, May 4, 1993 at 2.

production facilities. Alternatively, perhaps Motorola is motivated by concern for American workers. This explanation appears unlikely, however, given that Motorola has located manufacturing facilities in several foreign countries, including China, Malaysia, Singapore, and Taiwan. [46]

5. *The Limited Term of the License Increases the Risk Faced by Rival Producers.* Motorola is willing to license for up to the life of the standard. This could leave other producers with a set of products built around key pieces of Motorola intellectual property that these companies then no longer have the right to use.

The exact terms of some of the practices above are not clear at this point. However, to the extent that Motorola controls essential intellectual property, Motorola has the potential to limit competition through the specification of restrictive license terms. In the absence of concrete licensing arrangements, the uncertainties associated with being able to obtain licenses on reasonable terms can deter investment by actual and potential rivals.

V. CONCLUSION: A PUBLIC INTEREST APPROACH TO STANDARD SETTING

A public interest analysis of public safety radio leads to several conclusions. Sound public policy toward standard setting in public safety radio should:

- ***Set a spectrum efficiency performance standard.*** Such a standard is needed to ensure that public safety wireless users do not waste spectrum as a result of the lack of a price mechanism for allocating this scarce resource.

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[46] http://www.mot.com/AECG/General, March 17, 1997.

- ***Block the adoption of standards that harm competition.*** The federal government should not mandate a standard that has the effect of generating monopoly power for one provider, nor should it allow other parties to put such a standard in place pending the outcome of the open process called for in Section III.E above.
- ***Set in motion an open and democratic process to develop a means of achieving interoperability.*** The result could be either:
  a. *An open, non-proprietary standard.* The value of open standards is widely appreciated, and indeed is becoming a central concern of modern antitrust policy. Such a standard ideally would allow greater competition and innovation.
  b. *The use of system sharing and interconnection gateways.* The use of adapters is well recognized as a way to promote competition and allow innovation while facilitating compatibility. The potential loss in variety—and the attendant social costs—associated with the imposition of technical compatibility standards can be avoided.

Whatever the outcome, it should be spectrally efficient and promote competition.

Finally, there are significant reasons to doubt that the APCO Project 25 specification would be a sound basis for a federally set standard, whether the process be either the exercise of buyer power by federal users or formal standard setting through a Commission rulemaking.